Impact of aerosol scheme, meteorology, and emissions on model skill in AeroCom and CMIP5 aerosol simulations.

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The general circulation models GISS-MATRIX, GISS-modelE, HadGEM2, and SPRINTARS contain interactive representations of atmospheric aerosols and have simulated the period 1980-2006 as part of the AeroCom Hindcast and CMIP5 Historical protocols. They provide 11 individual simulations that use diverse combinations of free-running or nudged meteorology, and AeroCom Hindcast or CMIP5 emission datasets. Model diversity is large: total extinction and absorption aerosol optical depths vary by a factor 2 and 4, respectively. Sulphate aerosol optical depth is associated with the lowest diversity, and sea-salt with the highest. For a given model, meteorology and emission dataset have little impact on global-averaged component optical depths.

Simulated total and component aerosol optical depths are compared to time series at 135 AERONET sites that provide at least 60 valid, level 2 version 2, monthly averages in the period 1990s–2006. Root mean square error and correlation between modelled and measured time series provide a measure of model skill at predicting total aerosol optical depth. Differences between free-running and nudged meteorology have a small impact on model skill. Free-running meteorology typically worsens model skill, although some locations see improvements over nudged meteorology. Known deficiencies in emission datasets can be identified in the model evaluation against AERONET. The emission dataset that includes inter-annual variability in emissions does not always lead to better performance compared to the decadal-mean dataset. The GISS models represent enhancement of black carbon absorption due to coating by other aerosol components, and compare well against AERONET almucantar retrievals of aerosol absorption optical depth.